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Title:	An Evaluation of the ASM2000 software
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Introduction:

The ASM2000 software is based on the NetCAM3 software (currently installed at RLUOB) with the main difference being enhanced multi-CAM head support. Therefore, as the NetCAM3 software has been previously tested, the current evaluation concentrated on performance related to multi-head operation. In addition, bug fixes and improvements to prior versions of the NetCAM3 code were incorporated into the ASM2000 V2.0.0 software package.

Hardware configuration:

The ASM2000 software was installed on a DELL model 7212 latitude 12 rugged tablet (see Figure 1 below and accompanying text for details). The tablet replaces the ASM1000 Manager.

Figure 1. DELL tablet

- DELL 7212 Latitude 12 rugged touch screen tablet
- Windows 10 64 bit OS
- 12.3"x8.0"x0.96"   weight= 2.82lbs
- 11.6" HD display
- Docking station required for Ethernet capability
- Ordered through Wildflower w/o camera, Bluetooth, WiFi and microphone
- Cost ~$ 2200

The ASM2000, like the ASM1000, allows up to 8 Alpha-Sentry CAM heads to be coupled to a single tablet i.e. Manager. During this evaluation, a shortage of cables and space limited the maximum of CAM heads to just three. The diagram below details how the tablet and CAM heads were connected.

Figure 2. Schematic of ASM2000 tablet with multiple CAM heads
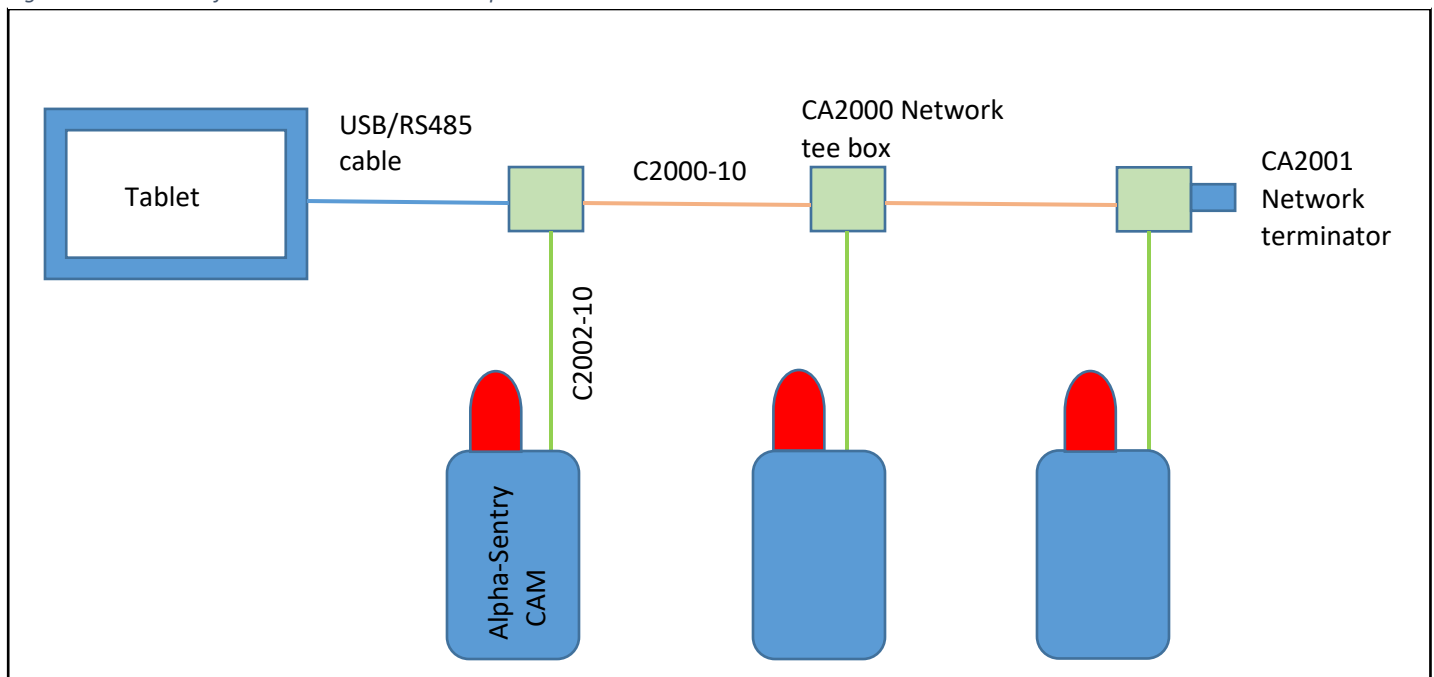
Note that with the exception of the USB/RS485 cable between the tablet and first network tee box, all cables and associated hardware are identical to that used with the ASM1000.

ASM2000 software:

The tablet is configured with two user profiles. The "Operator" account is the default profile under which the ASM2000 software runs. A password-protected "Administrative" account gives access to the Windows-based configuration settings and parameters (e.g. setting IP addresses and screensaver options).

When the tablet is powered on, a Virtual Box (VB)[1] interface opens and automatically searches for attached CAM heads. Once communication with the CAM heads is established, a FireFox browser is launched and the tablet displays the following ASM2000 log in screen (Fig.3):

Figure 3. ASM2000 login screen
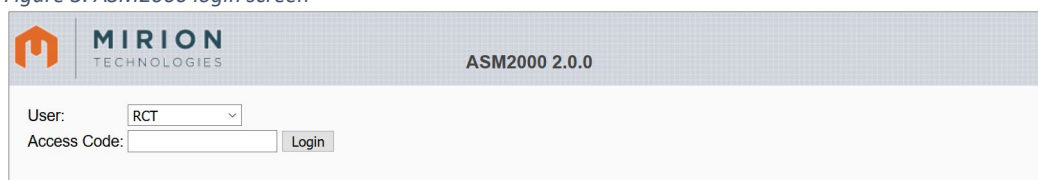
The default user account is "RCT"[2] for which no access code is required (i.e. just select "Login"). There are 4 other user accounts which, while granting increasingly more capabilities (e.g. modifying alarm set points), are password protected. A "RCT" user only has access to those functions necessary for routine operation and control of the ASM2000 software.

Once logged in, the default web page as shown in Fig.4 is displayed (after selecting a CAM head of interest from the row of status boxes showing the available attached CAMs).

For each attached CAM, a color-coded status box gives an overview of its current operating status (Fig. 4). The background color changes in response to alarm conditions (red), fault conditions e.g. low flow rates (yellow) or user-initiated tasks such as filter changes and performance tests (yellow). The bottom half of the display can be toggled to show the spectrum and associated parameters for any given CAM by selecting its status box. A stylus is provided with the tablet to navigate the ASM2000 interface but the evaluation relied on adding an external keyboard and mouse to the tablet in order to ease navigation.

By default, the spectral display "CAM Current Data" is shown but other options; "CAM Alarm Data" (most recent alarm spectrum), "CAM Trend Options" (flow rates, DAC-h and DAC) and "CAM Historical Data" (up to 24 hours-worth of data stored at the end of every count cycle) are also available for viewing.

Unlike the ASM1000, the ASM2000 software has just two main display pages. Clicking on the "ASM2000 Administration" link brings up the web page shown in Fig.5 for a "RCT" user. Other users will have more

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[1] The ASM2000 software was developed for a LINUX box. VB is the interface between the software and a Windows operating system
[2] The default user account is actually "StandardUser" with passcode "P@$$w0rd". These default options were modified at LANL via (routine) higher-level access to the ASM2000's configuration settings.

options available e.g. ability to modify configuration settings such as alarm set points. Clicking on the "ASM2000 System Display" takes the user back to the main display page (Fig.4).

Figure 4. ASM2000 main display page. Two CAM heads at positions 1 and 4 are connected to the Tablet
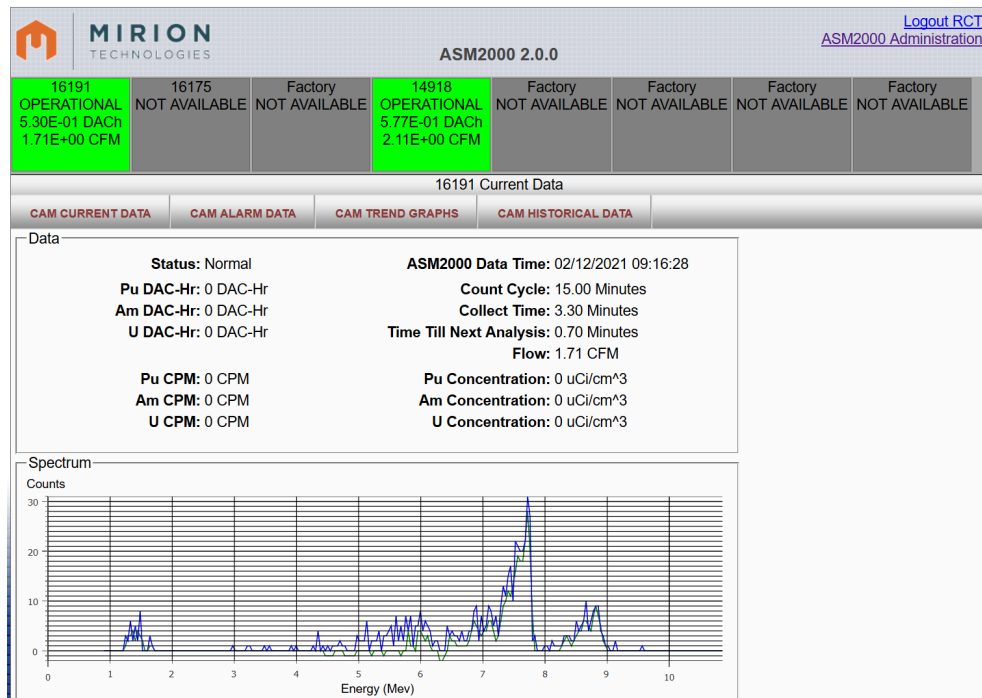

Figure 5. ASM2000 Administration web page

A DOS-like console interface program (Fig. 6) is co-loaded with the ASM2000 software and runs in the background. Many of the ASM2000 configuration parameters can also be setup using the console interface. This interface also has additional information not available within the ASM2000 application. For example, the dates at which the last flow rate and efficiency calibrations were done.

Figure 6. Console Interface for the ASM2000
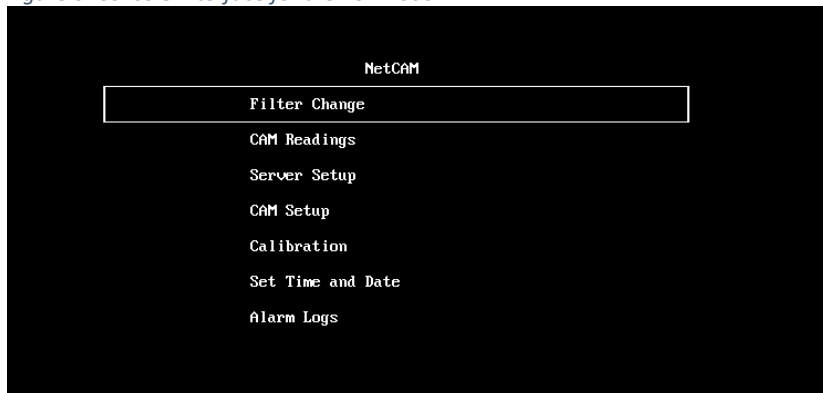
The following Table compares the features and capabilities of the ASM1000 and ASM2000. In general, there is a 1:1 correspondence in capabilities but the respective layouts are quite different so it will take time to become familiar with ASM2000 operation. Again, most features and capabilities can be access controlled by both Managers.

Table 1. Comparison of ASM1000 and ASM2000 features and capabilities

Property or Function	ASM1000	ASM2000
Chronic alarm update frequency	End of every count cycle	User selectable. As often as every minute during count cycle
Chronic alarm annunciation	Fixed alarm limit only	Fixed only, dynamic sigma-based only, or both (i.e. either can trigger an alarm)
Chronic alarm algorithm	Valleys (ROI) mode	Valleys or Peak fitting mode
Chronic alarm modes	DAC or DAC-h	DAC or DAC-h
Acute alarm algorithm	Exactly the same	
Alarm parameters	CAM-specific setup under "System Setup" menu	CAM-specific setup under "Administrative Actions"
Modifying CAM alarm annunciations	Requires external PC program	Accessible from "Administrative Actions" page
Non-physical values displayed	Yes (i.e. negative values shown)	No (<0.0 displayed as 0.0)
Trend graphs	Net cpm, flow, conc. and DAC-h.	Same data available on main display page
Filter change & Performance check	Under "System Setup" menu	Under " Administrative Actions" currently no access code required

Current CAM data	Spectrum, cpm, flow rate, DAC-h, conc. and alarm status.	Same data as ASM1000 is available on main display page
Status of attached CAM heads	Current status under "Network display" menu	Individual color-coded status boxes on main display page
Alarm and trouble log	Accessible from ASM1000	Accessible from console interface but not all trouble conditions are logged
Spectra	Last cycle, last alarm and current spectrum under "Data Review" menu	Last 24h of count cycle data, last alarm and current spectrum accessed from main display page
Adding/ deleting CAM heads	Auto or manual	Auto only
Date and time of last filter change and total volume	Under "Detailed Display" menu	Accessible from Console interface
Spectrum update frequency	~ every 10s	~ every 25s
Firmware updates	Possible with external PC and RS232 cable	Under "Administrative Actions" done over internet or with flash drive
CAM detection efficiency listed?	Yes, on "Performance Check" page	Accessible on console interface
Performance test cancel option	Yes	No (can't be cancelled)
Source activity for Performance Test and related parameters	Under "System Setup" menu	Under "Administrative Actions"
Help feature	Yes (on selected items)	No
Manual start/stop and reset	Yes	No but console interface might
Diagnostic tests	Yes	Strobe lamp check and Audio check only
CAM serial numbers displayed ?	Yes	On console interface only
User levels and assigning of allowed tasks	4 levels. Password controlled. Requires external PC setup program	5 levels. Password Controlled. Setup on "Administrative Actions"
Flow rate & efficiency calibration dates	Under "Detailed Display" menu	Accessible through console interface
Flow rate calibration	Yes with proper user level access	Available with console interface but needs verification it works
Efficiency calibration	Yes with proper user level access	Yes with proper user level access or from console interface

ASM2000 test plan and resulting observations:

1) *Long-term continuous operation of 2 or more CAM heads attached to same tablet.*
   a. *Any issues with communication loss with CAM heads (e.g. CAMs going off-line for no apparent cause)?*
   b. *Any radiation alarms? If so, are there plausible explanations ?*

A tablet running the ASM2000 v2.0.0 software was in continuous operation for almost 7 months. During that time 2 and sometimes 3 CAM heads were attached. There were no incidents where any CAM head lost communication with the tablet.

2) *Verify RadHawk is logging data from each CAM head on a daily basis.*

   RadHawk is a remote monitoring software program based on the RadNet protocol. The program permits the operating status of multiple CAM heads to be viewed simultaneously over a network. The software also logs the spectral and measurement data on a daily basis for each CAM head. Testing confirmed that RadHawk was displaying and logging CAM data correctly.

   Unfortunately, the current version of RadHawk (1.6) only runs on 32bit systems. Canberra/Mirion has long promised a 64bit version will be released someday soon.

3) *Verify that local and remote browsers can log in and successfully modify/update configuration settings for individual CAMs without causing issues.*
   a. *Will other CAMs respond to an alarm condition during configuration (including the necessary CAM reboot following any changes)*

   On multiple occasions the configuration parameters for one CAM were modified either through the local browser interface (tablet) or from a browser on a remote networked PC host. These changes and the subsequent reboot of the tablet to make the changes permanent caused no disruption in service with the other CAMs.

4) *Exercise the menu items associated with each CAM head (CAM current data, CAM alarm data, CAM trend graphs and CAM historical data)*
   a. *Log any issues found (e.g. sluggish behavior)*

   The ASM2000 tablet touch screen is very responsive and quick to respond to user commands. No issues were found while navigating between the above menu selections. On occasion, the tablet was sluggish to respond i.e. taking perhaps 15-30s to respond when normally the response was instantaneous. This sluggishness was observed ~5 times over the course of the evaluation and was always fixed by restarting the AMS2000 software. It was confirmed that the acute alarm was still active during these periods of sluggish behavior.

   Care was taken to make sure that "CAM current data" was selected after viewing the other menu options as the "CAM alarm data" and "CAM historical data" static displays were very similar to the "CAM current data" display.

5) *Performance tests and Filter changes:*
   i. *Verify that a performance test/filter change can be done on individual CAM heads without causing disruptions with other CAMs.*
   ii. *Are the cues displayed in the CAM's status box straightforward and unambiguous ?*

iii. *Document any performance test/filter change failures*
iv. *Will an on-going performance test/filter change prevent an alarm annunciation by other CAMs ? (e.g. using the DRS to generate chronic alarms and a check source for acute alarms)*
1. *Can an alarm on another CAM be acknowledged both locally and remotely during a performance test ?*

i. A Performance test on one CAM while simultaneously performing a filter change on another caused no issues.
ii. The cues (prompts displayed in the relevant CAM status box) were straightforward and indeed needed to be followed rather than anticipating the next action e.g. opening the filter access door prior to the cue to do so can cause issues.
iii. No issues with performance testing or filter changes were reported.
iv. No incidents were documented where a CAM alarm was prevented by user interactions with another CAM. It was also demonstrated that a CAM alarm can be acknowledged (horn silenced) locally though the tablet or through a browser on a remote PC host while a performance test is being done on another CAM head.

6) *Alarm testing using the dynamic radiation source (DRS) and check sources*
   a. *Verify acute and chronic alarms are annunciated and can be acknowledged locally and remotely*
   b. *Verify DAC-h and DAC alarm modes function in expected manner as based on alarm limits*
   c. *Do all CAMs annunciate an alarm condition if any one CAM alarms ?*

   The acute and chronic alarms annunciated as expected. The chronic alarm was tested using the fixed alarm mode, the dynamic sigma-based alarm mode and with both modes active (i.e. the first to exceed their alarm limit activates an alarm). Due to the ~25s spectrum refresh interval, the CAM's status box did not switch from a green (normal) to red (alarm) background for several seconds after the activation of the horn and strobe light i.e. contradictory indications. Interestingly, RadHawk seemed to give an instant update when an alarm condition occurred i.e. little or no lag time even though the update frequency was set to 30 seconds in the case of an alarm.

   However, inconsistent behavior was often noted in acknowledging the radiation alarms. Silencing the horn from the browser (Fig. 4) was almost always successful with a single acknowledgement (though sometimes two were needed) and initiating a subsequent filter change always cleared the CAM strobe light. But the status box for the affected CAM often continued to display the Alarm message long after the filter change and even into the next count cycle even though there was no trace of TRU activity in the CAM spectra (the source was removed during the filter change). Sometimes the Alarm message eventually cleared on its own but often, it was only cleared through repeated alarm acknowledgements. In at least one instance it was necessary to power cycle the CAM head to clear the alarm message. It was also observed that in these acknowledge-

resistant cases, RadHawk reported the operating status of the CAM head was under local control and the hardware status was labeled as out-of-service. When in this mode, RadHawk was frozen and continued to display the alarm spectrum even though the tablet spectrum updated in a normal fashion. Only when the alarm message finally cleared did RadHawk immediately revert to normal operation.

Only the CAM being tested responded to an alarm condition. The other CAMs continued to operate normally.

7) *Recovery from a fault condition (e.g. flow alarm or door open alarm)*
   a. *Does a fault condition on a CAM have an adverse effect on others ?*
   b. *Does the "Acknowledge alarm" feature restore normal operation ?*
   c. *If a CAM head goes off-line (green LED no longer lit)*
      i. *Does this cause issues with remaining CAMs ?*
      ii. *Can the remaining CAMs annunciate an alarm condition ?*
      iii. *Can it be brought back online without disrupting operation of the other CAMs ?*

Most fault conditions (e.g. low flow rate or door open) could be readily addressed using the Alarm acknowledgement button on the Administrative Actions page (Fig.4). Usually only one acknowledgement was required but sometimes two or more were necessary. For more serious faults (e.g. Instrument Fault), a reboot of the software was often required which affected all the CAMs by taking them out of service while the reboot was in progress (~ 2 minutes).

As mentioned above, an alarm acknowledgement was not always successful the first time or even, in some extreme cases, after 10 or more attempts.

In one case, a CAM head reported a "Flow Sys Failure" (probably due to the attached pump cycling on and off due to thermal overload). The collection time was almost 900 minutes (somewhat exceeding the 15 minute count cycle time) but otherwise all appeared normal including the accumulated spectrum. Without clearing the spectrum, the CAM responded appropriately when a check source was used to generate a chronic alarm condition (the acute alarm had previously been effectively disabled by raising the acute multiplier).

No CAM heads went off-line during the testing.

8) *Does the Tablet automatically detect the presence of a newly added CAM head and bring online without user intervention (i.e. as does the ASM1000) ?*
   a. *Can a CAM head be gracefully removed (e.g. for calibration) without causing havoc ?*
      i. *What is the procedure for doing so ?*
   b. *Newly added CAMs (if offline for more than 24 hours) will automatically undergo linearization after the first count cycle. Does this cause any issues with the other CAMs – particularly their ability to alarm ?*

During the testing, CAM heads were decoupled after removing power, the C2002 communication cable and vacuum. This did not cause any issue for the ASM2000 software. When a new CAM head replaced the old one, the software was able to automatically locate and bring the CAM head on-line. Unlike the ASM1000, there is no manual method of adding and deleting CAM heads with the ASM2000.

A common linearization time - set through the ASM2000 software by a user with the necessary login credentials – is applied to all the attached CAM heads. But it was observed that the linearization times are actually staggered by the software (Δt= 1hour) to prevent all CAMs being out of service at the same time. No issues were found during linearization (~ 7 minute process per CAM).

It was verified that a CAM undergoing linearization does not prevent an alarm condition being annunciated by the other attached sampling heads.

9) *Can a tablet be changed out without creating havoc ?*
   a. *If so, what is the procedure ?*

Only a single tablet was installed with the ASM2000 software so this could not be checked. However our experience with the NetCAM3 software indicates this should not be an issue as long the old tablet is powered off before removal and the new tablet not powered up until all the CAM heads are attached.

10) *Daily linearization*
    a. *Can the CAMs respond to a radiological alarm (acute and chronic) during linearization ?*

CAM heads did annunciate acute alarms while in linearization. However, testing of the chronic alarm using a dynamic radiation source was inconclusive as the time necessary to accumulate sufficient "activity" on the filter was comparable to the linearization time.

11) *The default alarm mode is the "Valleys" also known as the tail fitting or ROI mode. It's possible that the ASM2000 software upgraded the "Peaks" mode of operation also known as the peak fitting mode. If so, it would be useful to exercise this alarm option as well (it's the first parameter on the "Server Analysis and Calibration" configuration page).*

Discussion with the ASM2000 code developers confirmed that the Peaks mode of operation had not been modified when transitioning from the NetCAM3 to ASM2000 software. Prior NetCAM3 testing had shown that the Peaks mode is not as stable as the Valleys mode, so no further testing was done using this chronic alarm analysis mode.

Other observations and issues with the ASM2000 software:

Over the course of the evaluation period, several observations of interest were noted as summarized below. It should be mentioned that during the evaluation, the tablet and CAMs were often left unattended for long periods of time (up to 10 days) which would not be the case when deployed in the field. In addition, filter changes were relatively infrequent (sometimes up to a month between changes) which often resulted in low flow alarms for days prior to a filter change. Also the pumps (one per CAM head) would sometimes power cycle due to thermal overload - again something unlikely to occur when deployed - which was suspected to be responsible for at least one of the observations below.

1) A nuisance text box asking if an update of the FireFox browser was desired popped up on a regular basis (Fig.7) and had to be acknowledged to make it (temporarily) disappear. Despite several efforts, this message could not be permanently disabled.

Figure 7. Annoying pop up text box
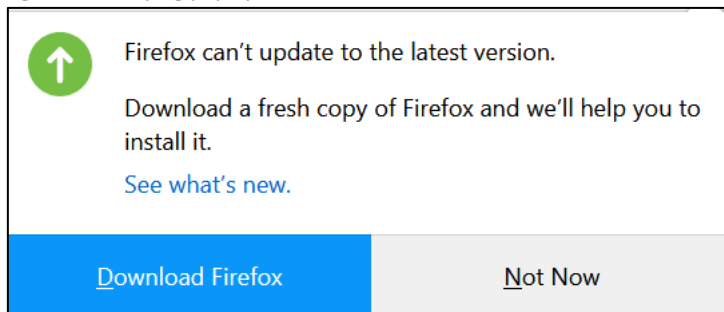
2) Frequent logouts or tab crashes of the Firefox browser were observed – about one every 7-10 days on average. They were characterized by three different types of tablet displays. The most frequent was the log in screen (Fig. 3) but the messages shown in Figs. 8 and 9 were also seen. Logging in again or refreshing the browser usually restored normal operation (Fig. 4). Though in a few instances (~ once a month), the tablet's web pages were sluggish to respond to user requests e.g. taking 15-20 s to execute a command. But it was verified that the CAM could annunciate an acute alarm condition while in this sluggish mode. Normal responsiveness could be restored in about 2 minutes by closing the browser, closing and restarting the Virtual Box Manager and reopening the browser.

However, in one instance of a "503" crash (Fig. 8), a casual glance of the restored browser appeared to show normal operation had been resumed without the need to restart VB and the browser. However, when a filter change and testing of the horn and light functions were attempted, the tablet failed to execute these requests despite the display of reassuring messages (e.g. "filter change command sent"). A restart of VB and the browser was needed to restore normal operation.

3) The following occurrence was reported to Mirion on 12/14/2020.

After a couple of weeks working at home, a trip to the office and a check of ASM2000 CAMs seemed to indicate all were working normally (the CAMs were reporting "Normal

Operation"). It took a closer look to see that the clock time (ASM2000 data time) was displayed as 12/04/20 on all three attached CAM heads (i.e. a lapse of 10 days). Though the green LEDs on the sampling heads were lit and the LEDs in the USB cable were twinkling, the spectra were not being updated either. None of the trend indicators nor the historical data had been updated either since 12/04/20. However, the count cycle time was being updated and reset every 15 minutes at the end of each cycle.

A check source was able to generate an acute alarm in one of the CAMs but the response appeared to be sluggish as it took about a minute to alarm whereas it normally took 30 seconds. All attempts to acknowledge the alarm were futile i.e. the horn could not be silenced. Removing the source and CAM power restored normal service though it took ~ 5 minutes for the CAM head to be recognized again by the tablet – again much longer than usual.

Attempts to exercise the lamp or audio on any of the three attached CAMs failed as did filter change commands. The browser also refused to revert back to the System Display page. After a few minutes, a "Request Timeout" message was posted. A reboot of the tablet was required to restore law and order.

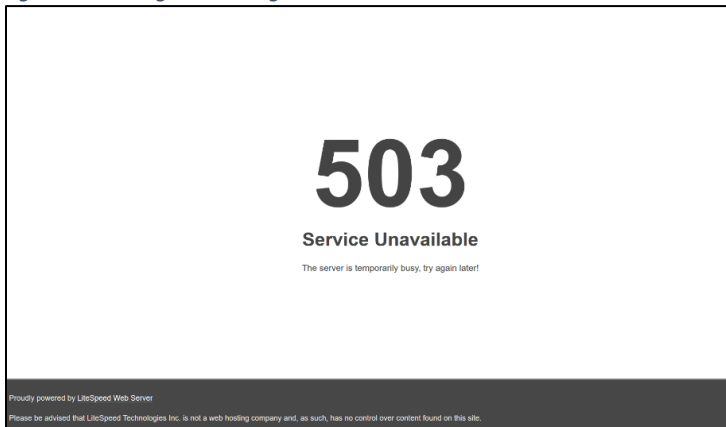*Figure 8. Message indicating browser had crashed*

Figure 9. Another message indicating the browser had crashed. Clicking "Restore This Tab" usually successful